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HIGH ALTITUDE VEHICULAR EMISSION CONTROL PROGRAM

VOLUME III. IMPACT OF ALTITUDE ON VEHICULAR EXHAUST EMISSIONS

AUTOMOTIVE TESTING LABORATORIES,
INCORPORATED

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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Emission data were developed from a sample of resident vehicles in Leadville, Colorado at a nominal elevation of 10,000 feet above sea-level. Emissions concentration sampling was performed on each vehicle in the sample at loaded and unloaded engine operating conditions. Concentration data were then converted to mass data using equations developed from key-mode and mass emissions testing of vehicles operating in the Denver area. Mass emissions data were than combined with mass data developed from vehicles operating in a metropolitan area situated near sea-level (Chicago) to define the emissions versus altitude relationships for exhaust HC, CO and NOx. HC and CO emissions at idle were also examined with respect to the applicability of a statewide minimum HC/CO idle emission standard for the state of Colorado.

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PREFACE

This report is the third of a seven volume report prepared for the State of Colorado, Department of Health and the Environmental Protection Agency, Region VIII. The title of each respective volume is as follows:

Volume I Executive Summary

Volume II Experimental Characterization of Idle Inspection, Exhaust Control Retrofit and Mandatory engine Maintenance

Volume III Impact of Altitude on Vehicular Exhaust Emissions

Volume IV Analysis of Experimental Results

Volume V Development of Techniques, Criteria, and Standards to Implement a Vehicle Inspection, Maintenance, and Modification Program

Volume VI The Data Base

Volume VII Experimental Characterization of Vehicular Emission and Engine Deterioration

These reports describe the design, conduct, findings and conclusions of study programs initiated in compliance with the requirements of the Colorado Department of Health and the Environmental Protection Agency. Volume III describes the design of an experimental program to investigate the impact of altitude on vehicular exhaust emissions as relating to the establishment of minimum statewide idle emission standards and the affect of altitude on resident vehicles.

SUMMARY

Emission data were developed from a sample of resident vehicles in Leadville, Colorado at a nominal elevation of 10,000 feet above sea-level. Emissions concentration sampling was performed on each vehicle in the sample at loaded and unloaded engine operating conditions. Concentration data were then converted to mass data using equations developed from key-mode and mass emissions testing of vehicles operating in the Denver area. Mass emissions data were then combined with mass data developed from vehicles operating in a metropolitan area situated near sea-level (Chicago) to define the emissions versus altitude relationships for exhaust HC, CO and NOx. HC and CO emissions at idle were also examined with respect to the applicability of a statewide minimum HC/CO idle emission standard for the State of Colorado.

Contrary to expectations both mass CO emissions and CO emissions at idle were found to be lower from 1967 and older model-year vehicles operating in the Leadville area than from a similar sample of vehicles operating in the Denver area. These findings would indicate that vehicles operating at the higher elevations were probably modified in an attempt to improve vehicle operating characteristics. Also, since idle CO emissions were generally lower from vehicles operating at the extreme high in elevation than from vehicles operating at lower elevations, a minimum HC/CO idle emission standard appears to be impractical for statewide application.

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1. CONCLUSIONS

1.1 Exhaust HC emission concentrations from resident vehicles at idle tend to be higher with increasing elevation from sea-level to 10,000 feet above sea-level.

1.2 CO emission concentrations from resident vehicles at idle tend to be lower at 10,000 feet than at 5,500 feet above sea-level. Since this phenomenon is in conflict with combustion theory, it can be concluded that vehicles operating at the higher elevations have been modified, presumably to improve vehicle performance characteristics at the higher elevations.

1.3 Because of the reversal affects of CO emissions at idle, the establishment of minimum statewide idle emission standards does not appear to be practical.

1.4 Mass HC emissions from all vehicles tend to be higher from resident vehicles at successively higher elevations while mass NO_x emissions tend to be lower.

1.5 Mass CO emissions from 1968 and newer model-year vehicles tend to be greater from resident vehicles at successively higher elevations. However, mass CO emissions from the 1967 and older model-year resident population tend to be greater at 5,500 feet than at either sea-level or 10,000 feet, which again indicates that vehicles operating at the higher elevations have been modified.

2. RECOMMENDATIONS

2.1 Since the data generated indicates that idle CO emission concentrations are lower from vehicles operating in the Leadville area than from vehicles operating in the Denver area, a minimum statewide HC/CO idle standard does not appear to be practical. It is recommended that prior to adoption of idle HC/CO emission standards for the higher elevations in the state, a more comprehensive study be initiated to more clearly define the emission versus altitude relationship.

3. INTRODUCTION

One of the major problems facing the State of Colorado with respect to its vehicular caused air pollution is that of altitude. The topography in the state ranges from a low of 3,000 feet to a high of over 14,000 feet above sea-level. In this regard, two major factors exist which stand as obstacles to emission control and abatement efforts. Engine control parameters are calibrated primarily for operation at sea-level and unmodified motor vehicle engines emit higher concentrations of exhaust hydrocarbons and carbon monoxide at higher elevations.

The State of Colorado currently has under consideration a program to control motor vehicle emissions. An act which passed the Colorado Legislative in 1973, Senate Bill 393, directed the Colorado departments of health and revenue to complete certain testing programs and studies and make recommendations to the governor and general assembly. An overall program was subsequently developed, contractors were selected, and contracts were let. The initial thrust of the overall program is to develop emission effectiveness and cost data which may be expected through application of various emission control strategies in Colorado. Because of the wide range of elevations in the state and possible differences in effectiveness of the strategies at the various elevations, a requirement for basic emissions data as a function of altitude developed. This report, Volume III, is one of seven volumes of study reports which have been prepared in response to Senate Bill 393. It is addressed primarily toward that paragraph of the bill which relates to the establishment of minimum statewide standards. It describes the design, conduct, findings and conclusions of a program designed to develop vehicular exhaust emissions data for hydrocarbons, carbon monoxide and oxides of nitrogen as a function of altitude.

4. TECHNICAL DISCUSSION

4.1 PROGRAM OBJECTIVES

The objective of the program was to develop vehicular exhaust hydrocarbons, carbon monoxide and oxides of nitrogen emissions data as a function of altitude.

4.2 PROGRAM DESIGN

To support the objective of the study the following tasks were to be considered:

Mass emissions data were to be obtained from representative samples of light-duty vehicles operating at disparate elevations. These data were to be used to define the emissions vs altitude relationship.

Idle emissions data were to be developed at disparate Colorado elevations. These data were to be applied in consideration of minimum state-wide emissions standards.

In order to develop the data required, three elevations were selected; nominally sea-level, 5000, and 10,000 feet above sea-level.

Since it was well outside the scope of the project to accumulate data on a captive group of vehicles transported from one elevation to another, an alternate method of developing the curves was required. The method selected was comprised of utilizing certain existing data and the generation of new data. In the design of the study, consideration was given to the fact that climate has an indirect effect on emissions since vehicle maintenance and resulting emissions are determined to a large extent by climatological factors. In this respect, emission data were to be obtained from vehicles in sites meeting certain climatological and topographical criteria.

Since applicable emissions data were available from recent studies at sea-level and at medium elevation (Denver), these data were to be utilized to define a segment of each emission curve. Emissions data were not available to define the high elevation points on the curve, however, and were developed specifically for the purpose of this study.

4.3 DATA SOURCES

Data used to establish sea-level emission factors were extracted from an EPA study[1] which was performed by Automotive Testing Laboratories, Inc. under contract to the EPA (Contract No. 68-01-0455). The purpose of the study was to

levelop emission factors in six U.S. cities. ATL performed the Denver, Houston and Chicago phases of the study. In keeping with the requirements for data from vehicles operating in a seasonally cold climate, Chicago area vehicle test results were selected to be representative of sea-level emission data. These data were developed in the vicinity of Chicago, Illinois at an elevation of 600 feet above sea-level. Testing was completed in May of 1973.

Data used to develop medium elevation points on the emission curves were extracted from data generated for Volume II of this report. Tests were performed in ATL's permanent facility which is situated east of Aurora, Colorado at an elevation of 5,490 feet above sea-level.

Data used to define the high elevation points on the emission curves were developed in Leadville, Colorado, at an elevation of 10,050 feet above sea-level. Testing in Leadville was performed specifically to satisfy the objectives of this study.

4.4 TEST VEHICLES

As discussed, three samples representing vehicles operating at nominal elevations of sea-level, 5,500 feet and 10,000 feet above sea-level were utilized. Since each sample was developed for different study purposes some deviation in sample composition occurs from site to site.

The Chicago area vehicle sample was originally selected by the EPA to be representative of nation-wide vehicle registrations. Vehicle distribution by model-year was weighted in accordance with annual mileage accumulation. As a result, the Chicago area vehicle sample is weighted toward the more recent model-year vehicles which are driven more miles each year than the older model-year vehicles. The Denver area vehicle sample was selected to represent light-duty vehicles registered in Colorado without regard for annual mileage accumulation. Vehicles tested in Leadville were selected to approximate the distribution of Chicago and Denver area vehicle samples. Sample composition for each of the test sites is shown in Tables 1, 2, and 3. A detailed description of each of the vehicles tested is presented in Appendix 1.

4.5 TESTING PROCEDURES

Tests utilized to define the emission curves were performed on each vehicle

CHICAGO

MAKE	72	71	70	69	68	67	66
AMMO	1	-	1	-	1	1	1
BUICK	3	2	2	2	1	1	1
CADI	1	-	-	1	1	-	1
CHEV	8	7	5	5	5	5	4
CHRYS	1	-	1	-	1	1	-
DODGE	2	2	2	1	1	1	1
FORD	7	6	6	5	5	3	3
IMPE	-	-	-	-	-	-	-
LINC	-	1	-	-	-	-	-
MERC	1	1	1	1	1	1	1
OLDS	2	2	2	2	1	1	1
PLYM	3	2	2	2	1	1	1
PONT	2	2	2	2	2	2	2
VOLK	2	2	2	1	1	1	1
TOYO	1	1	1	-	-	-	-
DATS	1	1	-	-	-	-	-
OPEL	-	1	-	-	-	-	-
VOLVO	-	-	-	-	-	-	-
TOTAL	35	30	27	22	21	18	17

TABLE 1

DENVER

MAKE	73	72	71	70	69	68	67	66	65	64
AMMO	1	1	1	1	1	1	1	1	1	1
BUICK	1	1	1	1	2	2	2	2	2	1
CADI	1	1	1	1	1	1	1	-	2	1
CHEV	7	7	7	6	6	7	6	7	7	7
CHRYS	1	1	1	1	1	1	1	1	1	1
DODGE	2	2	2	2	2	2	1	2	2	1
FORD	8	8	9	8	6	5	6	7	7	4
IMPE	-	-	-	-	-	-	-	-	-	-
LINC	-	-	-	-	-	-	-	-	-	-
MERC	1	1	1	1	1	1	2	1	1	1
OLDS	1	1	1	2	2	2	2	2	2	1
PLYM	3	3	3	2	2	2	2	2	2	1
PONT	1	1	2	2	2	3	3	2	2	2
VOLK	3	3	2	2	2	2	2	2	1	1
TOYO	1	1	1	1	1	1	-	-	-	-
DATS	1	1	1	-	-	-	-	-	-	-
OPEL	1	1	1	-	-	-	-	-	-	-
VOLVO	-	-	1	-	-	-	-	-	-	-
TOTAL	33	33	35	30	29	30	29	29	30	22

TABLE 2

LEADVILLE

MAKE	73	72	71	70	69	68	67	66	65	64
AMMO	1	1	1	1	1	-	1	1	-	1
BUICK	1	1	1	1	1	1	1	1	1	1
CADI	-	-	-	1	-	-	-	-	-	-
CHEV	4	4	4	3	3	4	3	4	3	4
CHRYS	1	1	1	-	-	1	1	1	1	-
DODGE	1	1	1	1	1	1	-	1	1	1
FORD	4	-	4	4	3	3	3	4	4	2
IMPE	-	-	-	-	-	-	-	-	-	-
LINC	-	-	-	-	-	-	-	-	-	-
MERC	1	1	1	1	1	1	1	1	1	-
OLDS	1	-	1	1	-	1	1	1	1	-
PLYM	1	1	1	-	1	1	1	1	1	-
PONT	1	1	1	1	1	2	1	1	1	1
VOLK	2	-	2	2	2	1	1	1	1	1
TOYO	1	1	1	-	-	-	-	-	-	-
DATS	-	-	-	-	-	-	-	-	-	-
OPEL	-	-	-	-	-	-	-	-	-	-
VOLVO	-	-	-	-	-	-	-	-	-	-
TOTAL	19	12	19	16	14	16	14	17	15	11

TABLE 3

in the as-received condition. Mass emission tests on Chicago and Denver area vehicles were performed according to the EPA testing procedures for the 1975 model-year light-duty vehicles. Analytical instrument calibrations for Chicago and Denver area testing were developed from a common set of gaseous standards. Identification of the gas standards was performed at the EPA laboratories in Ann Arbor, Michigan. Since it was outside the scope of the study to conduct mass emission tests in Leadville, an alternate emissions sampling strategy was employed to develop data which could be related to mass emission data.

As a result of a study performed in 1972 by ATL for the EPA, Region VIII, it was shown that mass emissions could be predicted with reasonable accuracy from a composite of key-mode emissions concentration data. For the study, key-mode (Clayton Mfg. Co.) and 1975 EPA emissions data were developed from tests performed on 75 each 1968 through 1972 model-year vehicles which had been operating in the Denver area. Since tests were performed on each vehicle before and after engine maintenance, 150 each tests were conducted totally. A multiple linear regression analysis was performed on the test data and correlation coefficients greater than 0.7 were shown to exist between composite key-mode emission concentration data and 1975 mass emission data. Since correlation coefficients between the data sets were found to be relatively high, it was concluded that key-mode emissions concentration data could be used to predict mass

emissions. A testing strategy suggested by this conclusion was applied to generate mass emission data from vehicles operating in the Leadville area at 10,050 feet above sea-level.

Data presented in Volume II indicates that over 900 emission testing sequences were performed on 300 vehicles. The purpose of the tests was to evaluate certain emission control strategies. Each of the testing sequences was comprised of mass emission tests by the 1975 EPA procedures, emission concentration tests by a key-mode test procedure and idle emission tests. Multiple linear regression analysis of certain data sets were performed and equations to convert composite key-mode emissions data to mass emissions data were developed. Details of the analysis and the equations which resulted are presented in Appendix 2.

4.6 TEST EQUIPMENT

Equipment employed to develop mass emission data from vehicles operating in the Chicago area is described in the referenced study report (Reference 1). Equipment used to develop mass emission data from Denver area vehicles is described in Volume II of this report.

For the 900 plus key-mode emission concentration tests performed in the Denver area to satisfy the objectives of the Leadville study, the following major pieces of equipment were used:

Clayton Mfg. Co., Model CT-200 chassis dynamometer to load test vehicles.

Sun Electric Company, Model EPA-75 emissions analyzer to measure HC and CO emissions.

Thermal-Electron Corp., Model 10A chemiluminescent analyzer to measure nitric oxide (NO) emissions.

The equipment used to generate emissions data in Denver was calibrated and operated in accordance with the procedures outlined in Volume II.

To generate emissions data in Leadville the following equipment was utilized:

Clayton Mfg. Co., Model CT-150 chassis dynamometer to load test vehicles.

Sun Electric Company, Model EPA-75 emissions analyzer to measure HC and CO emissions.

Beckman Instruments Div., Model 951 chemiluminescent analyzer to measure NO emissions.

The equipment utilized in Leadville was installed in facilities provided by Colorado Mountain College on its East Campus where testing was also performed.

5. TEST RESULTS

In the design of the study, two tasks were to be accomplished; the development of emission curves as a function of altitude and the development of idle emission data. The following paragraphs describe the results of the study with respect to the two tasks.

5.1 IDLE EMISSIONS DATA

To examine the applicability of minimum state-wide idle emission standards, data were collected from vehicles operating in the Denver area and in the Leadville area. Two light-duty vehicle populations were examined factory exhaust controlled 1968 through 1973 model-year vehicles and the uncontrolled 1967 and older model-year vehicles. Single mode (curb idle) emissions are shown in Table 4 for the 1967 and older model-year vehicles at the various rejection rates.

	Idle Emissions					
	Denver 5500 Ft.			Leadville 10,000 Ft.		
Rejection Rate (%)	HC (PPM)	CO (%)	NOx (PPM)	HC (PPM)	CO (%)	NOx (PPM)
0	2500	20.0	427	2500	10.0	1300
10	1450	9.6	126	2500	7.8	300
20	860	8.4	84	2500	6.1	110
30	760	7.6	72	1600	5.4	60
40	680	6.5	61	970	4.4	51
50	600	5.8	51	780	3.4	43
60	550	5.8	46	600	2.6	29
70	450	4.1	36	490	2.0	24
80	400	3.3	28	430	0.8	19
90	330	2.0	24	300	0.4	11
100	130	0.2	5	90	0.1	0

Table 4. Rejection Rates Versus Pass/Fail Limits for 1967 and Older Model-Year Vehicles.

From the data shown in Table 4, it can be seen that idle HC emissions from vehicles operating in the Leadville area are generally higher than HC emissions from vehicles operating in the Denver area. However, idle CO emissions from Leadville vehicles are generally lower than CO emissions from Denver vehicles. Since the reversal affect of CO emissions from a lower to a higher elevation appears to be in conflict with combustion theory, it can be concluded that vehicles operating at the extreme high in elevation were modified in an attempt to improve vehicle operating characteristics. Idle emissions data for the 1968 and newer model-year vehicles as shown in Table 5, show trends similar to those shown for the older model-year vehicles.

	Idle Emissions					
	5500 Ft.			10,000 Ft.		
Rejection Rate (%)	HC (PPM)	CO (%)	NOx (PPM)	HC (PPM)	CO (%)	NOx (PPM)
0	2500	20.0	2590	2500	9.0	1050
10	760	8.2	153	1100	6.8	175
20	580	6.6	101	740	5.0	110
30	440	5.6	88	590	4.4	72
40	350	4.8	77	500	3.2	62
50	290	4.2	70	440	2.8	50
60	250	3.2	64	400	2.0	46
70	220	2.7	55	360	1.2	40
80	170	1.7	50	320	0.7	32
90	130	0.7	38	230	0.3	23
100	20	0.1	10	110	0.1	2

Table 5. Rejection Rates Versus Pass/Fail Limits for 1968 and Newer Model-Year Vehicles

From an examination of the data shown in Table 5 it can be seen that an HC standard of 440 ppm, for example, applied state-wide, would fail about 30% of the Denver area vehicles. The same 440 ppm HC standard would fail about 50% of the vehicles in Leadville. On the other hand, a state-wide CO standard of 3.2%, for example, would fail about 60% of vehicles in Denver but only 40% of vehicles in Leadville. From this discussion it can be concluded that minimum statewide

standards are probably inappropriate because of the reversal affects of idle CO emission from low to high elevation.

5.2 MASS EMISSIONS DATA

A computer analysis was performed on emission data developed at nominal elevations of sea-level, 5500 feet and 10,000 feet above sea-level. Results of this analysis are reported in Appendix 3. A summary of emissions data for all cars as a function of altitude is presented in Table 6.

ELEVATION (Feet)	EMISSIONS IN GRAMS PER MILE		
	HC	CO	NOx
600	5.15	59.0	4.30
5500	7.98	110.3	2.59
10,050	10.75	125.9	1.68

Table 6. Summary of Exhaust Emissions at the Various Elevations

As indicated in Table 6, mean mass emissions for all vehicles at the various altitudes tend to follow the trends which would normally be expected. Mean HC and CO emissions for all vehicles tend to increase with successively higher elevations while NOx emissions tend to decrease. A closer examination of mass emissions at higher elevations, however, indicates that the trends do not apply to the total vehicle population.

Figures 1, 2 and 3 depict exhaust HC, CO and NOx emissions visually for the two vehicle populations (the 1967 and older model-year vehicles and the 1968 and newer model-year vehicles). As can be seen in Figure 1, and as may be predicted, mean HC emissions from each population tend to increase with successively higher elevations. Conversely, mean NOx emissions (Figure 3) tend to decrease with successively higher elevations. However, CO emissions from the 1967 and older model-year vehicles (Figure 2) tend to decrease from 5500 feet to 10,000feet above sea-level. This observation also supports the contention that vehicles operating in the Leadville area at a nominal elevation of 10,000 feet above sea-level have been modified.

5.3 SUMMARY OF OBSERVATIONS

1. Exhaust HC emission concentrations at idle tend to increase with increasing elevation as indicated by tests on resident vehicles.

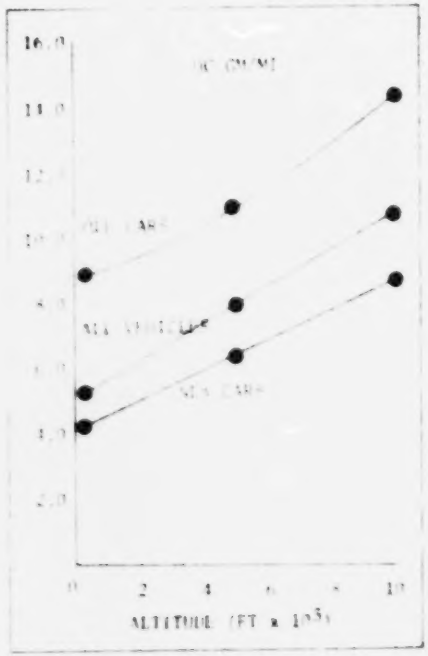

FIGURE 1

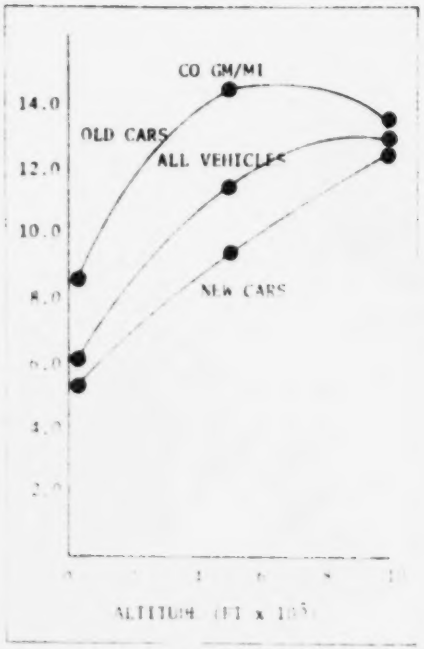

FIGURE 2

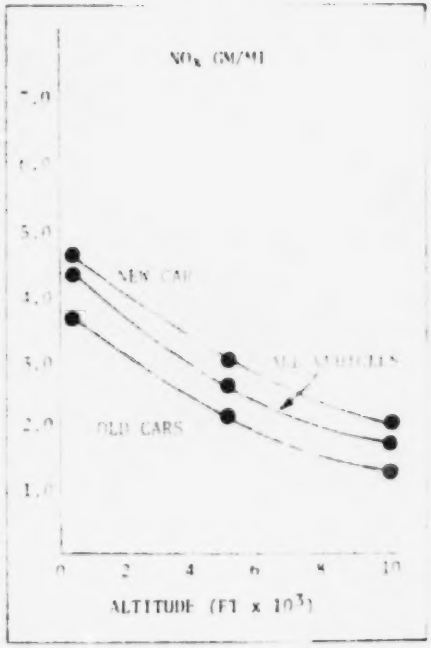

FIGURE 3

However, idle CO emissions from vehicles operating at 10,000 feet tend to be lower than idle CO emissions from vehicles operating at 5,500 feet.

2. A minimum HC standard at idle appears to be practical for statewide application although a uniform statewide standard would fail fewer vehicles at the lower elevations than at the higher elevations. A minimum CO standard at idle, however, does not appear to be practical since a uniform CO standard would fail more vehicles at lower elevations than an higher elevation.

3. Emission data indicate that mass HC emissions tend to increase with higher elevations while mass NOx emissions tend to decrease. However, mass CO emissions from the 1967 and older model-year population tend to be lowe at 10,000 feet than at 5,500 feet.

6. REFERENCES

1. A Study of Emissions from Light-Duty Vehicles in Denver, Houston and Chicago, Fiscal Year 1972, U.S. Environmental Protection Agency, APTD-1504, Contract No. 68-01-0455, Automotive Testing Laboratories, Inc., July, 1973.

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VEHICLES TESTED AT 600 FEET

VEH.	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
0501	1971	FORD	GALA	351	8	2	A	4000	036670
0502	1972	RAMB	HORN	258	6	1	A	3500	039961
0503	1972	BUIC	STAW	455	8	4	A	5500	018200
0504	1972	FORD	STAW	351	8	2	A	4500	012152
0505	1971	FORD	MUST	302	8	2	A	3500	017614
0506	1971	DODG	DEMO	225	6	1	A	3000	018565
0507	1971	FORD	GALA	351	8	2	A	4000	046712
0508	1971	FORD	MAVE	200	6	1	A	3000	016581
0509	1971	VOLK	SEDA	97	4	1	4	2000	009708
0510	1972	OLDS	98	455	8	4	A	5000	002861
0511	1972	FORD	GALA	351	8	2	A	4000	008155
0512	1970	OLDS	DELT	350	8	2	A	4500	018741
0513	1971	PONT	GRAN	455	8	2	A	4500	030510
0514	1970	MERC	MARQ	429	8	4	A	5000	045311
0515	1970	PONT	CATA	400	8	2	A	4500	029626
0516	1970	PLYM	FURY	318	8	2	A	4000	023030
0517	1972	CHEV	CAPR	400	8	2	A	4500	016049
0518	1970	FORD	GALA	351	8	2	A	4000	056714
0519	1969	FORD	LTD	302	8	2	A	4000	063805
0520	1972	BUIC	STAW	455	8	4	A	5500	019069
0521	1967	VOLK	SEDA	91	4	1	4	2000	085479
0522	1968	FORD	FALC	200	6	1	A	3000	046244
0523	1971	LINC	MARK	460	8	4	A	5500	016771
0524	1971	CHEV	IMPA	350	8	2	A	4000	038416
0525	1969	OLDS	CUTL	350	8	2	A	3500	020189
0526	1969	FORD	LTD	390	8	4	A	4000	066760
0527	1970	CHEV	IMPA	350	8	2	A	4000	030799
0528	1966	FORD	FAIR	200	6	1	A	3000	043365
0529	1967	PONT	VENT	400	8	2	A	4000	063044
0530	1972	VOLK	SQUA	103	4	FI	4	2500	006574
0531	1970	BUIC	LESA	350	8	4	A	4500	044001
0532	1968	PLYM	SATE	273	8	2	A	3500	023335
0533	1969	BUIC	SKYL	350	8	2	A	4000	028573
0534	1969	FORD	GALA	302	8	2	A	4000	035387
0535	1966	CHEV	CHEL	194	6	1	A	3000	055111
0536	1972	PLYM	SATE	318	8	2	A	3500	013940
0537	1972	FORD	MAVE	302	8	2	A	3000	001248
0538	1972	BUIC	LESA	350	8	2	A	4500	009132
0539	1971	DODG	MONA	383	8	2	A	4500	017138
0540	1972	CHEV	MALI	307	8	2	A	3500	006399
0541	1969	BUIC	WILD	430	8	4	A	4500	043148
0542	1972	VOLK	SEDA	97	4	1	4	2000	011004
0543	1966	PONT	BONN	389	8	2	A	4500	077429
0544	1968	MERC	MONT	302	8	2	A	3500	028751
0545	1967	CHEV	BELA	283	8	2	A	4500	077090
0546	1967	PLYM	FURY	318	8	2	A	4000	073054
0547	1971	OLDS	CUTL	350	8	2	A	4000	025290
0548	1972	OLDS	CUTL	350	8	2	A	4000	002907
0549	1969	CHEV	IMPA	327	8	2	A	4000	036412
0550	1972	CHRY	NEWP	400	8	2	A	4500	012502

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VEHICLES TESTED AT 600 FEET

VEH.	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
0551	1971	BUIC	SKYL	350	8	2	A	4000	028406
0552	1972	TOYO	CORN	120	4	2	4	2500	004758
0553	1971	PLYM	DUST	198	6	1	A	3000	043444
0554	1971	OPEL	1900	116	4	2	A	2500	031480
0555	1968	OLDS	CUTL	350	8	2	A	3500	058601
0556	1970	BUIC	ELEC	455	8	4	A	4500	032082
0557	1971	VOLK	SEDA	97	4	1	4	2000	026768
0558	1970	CHEV	CAMR	350	8	2	A	3500	023761
0559	1970	CHRY	STAW	440	8	4	A	5000	014476
0560	1972	PLYM	FURY	360	8	2	A	4000	015326
0561	1970	CHEV	IMPL	400	8	2	A	4000	033131
0562	1972	CADI	COUP	472	8	4	A	5000	007453
0563	1970	FORD	FAIR	302	8	2	A	3500	023963
0564	1969	DODG	MONA	383	8	2	A	4000	043095
0565	1970	FORD	FAIR	250	6	1	A	3500	026482
0567	1968	CHEV	CORV	164	6	2	A	2500	042288
0568	1968	BUIC	WILD	430	8	4	A	4500	044609
0569	1972	DODG	DEMO	225	6	1	A	3000	003257
0570	1966	CADI	DEVI	429	8	4	A	4500	100048
0571	1970	VOLK	SEDA	97	4	1	4	2000	027284
0572	1970	PONT	LEMA	350	8	2	A	4000	013677
0573	1966	CHEV	IMPA	283	8	2	A	4000	052001
0574	1968	CHEV	CAMA	327	8	4	A	3500	057276
0575	1970	FORD	MAVE	200	6	1	A	2500	030064
0576	1968	CHRY	NEWP	383	8	2	A	4000	052368
0577	1972	FORD	CAPR	122	4	2	4	2000	011115
0578	1968	CHEV	CHEV	396	8	4	A	3500	072217
0579	1969	VOLK	BUG	91	4	1	4	2000	038024
0580	1972	FORD	LTD	400	8	2	A	4000	002313
0581	1969	CHEV	IMPA	350	8	4	A	4000	050274
0583	1969	FORD	RANC	351	8	2	A	4500	041502
0584	1971	CHEV	VEGA	140	4	1	4	2500	020875
0585	1968	CHEV	BELA	307	8	2	A	4500	045841
0586	1970	FORD	COUN	351	8	2	A	4500	039931
0587	1971	FORD	CAPR	98	4	1	3	2500	017390
0588	1972	DODG	MONA	360	8	2	A	4500	000962
0589	1968	DODG	CORN	318	8	2	A	3500	047137
0590	1971	BUIC	LIMI	455	8	4	A	5000	024649
0591	1967	FORD	CUST	289	8	2	A	4000	069868
0592	1971	CHEV	IMPA	350	8	2	A	4000	010887
0593	1968	FORD	MUST	289	8	2	A	3000	041963
0594	1970	VOLK	SEDA	97	4	1	4	2000	039690
0595	1969	CADI	DEVI	472	8	4	A	5000	042617
0596	1968	CHEV	BELA	307	8	2	A	4000	030144
0597	1972	MERC	MONT	400	8	2	A	4500	008761
0598	1971	OLDS	DELT	455	8	4	A	4500	024160
0599	1972	CHEV	MONT	350	8	2	A	4000	007805
0600	1971	PONT	FIRE	350	8	2	A	3500	025161
0601	1969	MERC	MONT	390	8	2	A	4500	043951
0602	1966	PONT	GTO	326	8	4	A	4000	072618

VEHICLES TESTED AT 600 FEET

VEH.	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
0603	1971	CHEV	MALI	307	8	2	A	3500	008088
0604	1971	TOYO	CORO	96	4	1	4	2000	013732
0605	1967	OLDS	CUTL	330	8	2	A	3500	029979
0606	1969	CHEV	CAMA	307	8	2	A	3500	026475
0607	1966	CHEV	BISC	283	8	2	3	4000	051068
0608	1971	CHEV	CAPR	400	8	2	A	4500	026187
0609	1970	PLYM	VALI	225	6	1	A	3000	028064
0610	1968	CADI	FLEE	472	8	4	A	5000	030893
0611	1968	VOLK	SEDA	91	4	1	4	2000	045516
0612	1966	PLYM	VALI	225	6	1	A	3000	039711
0613	1969	PLYM	FURY	225	6	1	A	4000	062215
0614	1967	PONT	FIRE	326	8	2	A	3500	055683
0615	1969	OLDS	98	455	8	4	A	4500	057035
0616	1967	BUIC	LESA	340	8	2	A	4000	043038
0617	1969	PONT	LEMA	350	8	2	A	3500	026308
0619	1968	FORD	LTD	390	8	2	A	4000	054998
0620	1972	CHEV	CAMA	350	8	2	A	3500	011602
0621	1968	PONT	CATA	400	8	2	A	4000	063705
0622	1971	CHEV	IMPA	350	8	2	A	4000	025965
0623	1967	FORD	RANC	390	8	2	A	4000	053799
0624	1972	FORD	RANC	351	8	2	A	4500	012928
0625	1972	CHEV	CONC	402	8	4	A	4000	011287
0626	1970	FORD	CUST	302	8	2	A	4000	029889
0627	1968	PONT	TEMP	350	8	2	A	4000	081791
0628	1970	CHEV	MALI	307	8	2	A	3500	027343
0629	1970	OLDS	TORO	455	8	4	A	4500	017495
0630	1967	CHRY	NEWP	383	8	2	A	4000	021977
0631	1969	CHEV	NOVA	230	6	1	A	3000	057983
0632	1968	RAMB	JAVE	343	8	4	A	3500	038152
0633	1967	CHEV	IMPA	327	8	4	A	4000	080596
0634	1970	DODG	CORO	318	8	2	3	4000	050348
0635	1966	FORD	COUN	390	8	2	A	4500	095050
0636	1966	FORD	GALA	289	8	2	A	4000	074185
0637	1967	MERC	COLO	390	8	2	A	4500	108899
0638	1966	MERC	COLO	390	8	2	A	4500	054443
0639	1971	PLYM	SATE	318	8	2	A	3500	020944
0640	1966	VOLK	SEDA	78	4	1	4	2000	063624
0641	1972	PONT	LEMA	350	8	2	A	3500	011904
0642	1967	CHEV	BELA	283	8	2	A	4000	050885
0643	1969	PONT	CATA	400	8	2	A	4000	042621
0644	1971	MERC	MONT	400	8	2	A	4000	028391
0645	1966	OLDS	DELT	330	8	2	A	4000	093748
0646	1968	FORD	MUST	289	8	2	A	3000	039323
0648	1966	BUIC	LESA	340	8	2	A	4000	096040
0649	1972	CHEV	VEGA	140	4	2	A	2500	012571
0650	1972	DATS	510	97	4	2	4	2500	030030
0651	1970	TOYO	CORO	116	4	1	4	2500	032881
0652	1971	CHEV	CAPR	400	8	2	A	4500	040366
0653	1972	CHEV	IMPA	350	8	2	A	4500	019476
0654	1968	FORD	THUN	429	8	4	A	4500	038874

VEHICLES TESTED AT 600 FEET

VEH.	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
0655	1966	CHEV	IMPA	283	8	2	A	4000	082160
0656	1967	CHEV	NOVA	194	6	1	A	3000	096775
0657	1972	FORD	THUN	429	8	4	A	4500	016784
0658	1969	CHEV	NOVA	350	8	4	A	3000	101630
0659	1969	PLYM	FURY	318	8	2	A	4000	058945
0660	1967	CHEV	CAPR	283	8	2	A	4000	064776
0661	1972	CHEV	IMPA	350	8	2	A	4500	012889
0662	1967	FORD	COUN	289	8	4	3	4000	064936
0664	1972	PONT	GRAN	455	8	2	A	4500	022064
0665	1966	RAMB	CLAS	232	6	1	A	3000	066725
0666	1966	DODG	CHAR	361	8	2	A	4000	039063
0667	1971	FORD	LTD	429	8	2	A	4500	036522
0668	1969	FORD	FALC	200	6	1	A	3000	101973
0669	1970	DODG	POLA	318	8	2	A	4000	021957
0670	1970	CHEV	NOVA	230	6	1	4	3000	043198
0671	1972	PLYM	SATE	318	8	2	A	3500	025999
0672	1970	RAMB	REBE	304	8	2	A	3500	034152
0673	1967	DODG	POLA	318	8	2	A	4000	036116
0674	1967	RAMB	REBE	290	8	2	A	3500	032307
0675	1971	DATS	STAW	97	4	1	4	2500	021689

VEHICLES TESTED AT 5500 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
001	1965	OLDS	DELT	425	8	4	A	4500	040150
002	1967	MERC	COUG	289	8	4	A	3500	070863
003	1966	BUIC	LESA	340	8	4	A	4000	022750
004	1967	BUIC	SPEC	300	8	2	A	3500	048935
006	1967	CADI	SEDA	429	8	4	A	5000	104304
007	1966	CHEV	IMPA	327	8	4	A	4000	043884
008	1964	VOLK	SEDA	73	4	1	4	2000	105861
010	1966	CHRY	300	383	8	4	A	4000	066648
011	1966	CHEV	CHE2	194	6	1	3	3000	072251
012	1967	CHRY	STAW	383	8	4	A	5000	063004
013	1965	DODG	DART	225	6	1	A	3000	032679
014	1964	CHEV	CHE2	194	6	1	3	3000	049237
015	1967	FORD	STAW	289	8	2	3	3500	060240
016	1967	FORD	FALC	289	8	2	A	3000	059003
017	1966	CHEV	BISC	283	8	2	A	4000	051045
019	1965	AMMO	CLAS	232	6	1	3	3000	062545
020	1967	OLDS	DELT	425	8	4	A	4500	089113
021	1967	PLYM	BELV	273	8	2	A	3500	070009
022	1971	CHEV	VEGA	140	4	2	4	2500	040186
023	1973	FORD	STAW	400	8	2	A	5000	003001
024	1964	CHRY	NEWP	361	8	2	A	4500	099340
025	1966	DODG	VAN	273	8	2	3	3500	054740
026	1965	CADI	DEVI	429	8	4	A	5000	084961
027	1965	MERC	MONR	390	8	2	A	4000	072548
028	1964	OLDS	STAW	330	8	2	A	4000	089020
029	1965	PONT	TEMP	326	8	2	A	3500	059585
030	1964	CADI	DEVI	429	8	4	A	5000	048156
031	1964	CHEV	IMPA	327	8	4	A	3500	060672
033	1965	FORD	MUST	200	6	1	A	3000	065042
035	1965	DODG	POLA	383	8	2	A	4000	064463
036	1965	BUIC	SKYL	300	8	2	A	3500	075400
037	1964	FORD	FAIR	289	8	2	3	3500	052629
038	1966	FORD	GALA	390	8	4	A	4000	054529
039	1968	PONT	VENT	428	8	4	A	4500	069716
040	1968	FORD	CUST	302	8	2	A	4000	019445
041	1970	CHEV	NOVA	230	6	2	A	3000	030980
042	1969	PLYM	BELV	318	8	2	A	3500	039269
043	1971	FORD	MAVE	170	6	2	3	2750	020583
044	1967	CHEV	CAPR	327	8	4	A	4000	046046
045	1972	DODG	DART	225	6	1	A	3000	005414
046	1965	PLYM	VALI	225	6	1	3	3000	085428
048	1967	MERC	STAW	390	8	2	A	4500	064033
049	1967	CHEV	CAMA	250	6	1	4	3000	076864
051	1969	OLDS	DELT	455	8	2	A	4500	064800
053	1964	DODG	POLA	318	8	2	A	4000	042474
055	1966	FORD	MUST	200	6	1	A	3000	054749
056	1964	CHEV	BELA	230	6	1	A	3500	046660
057	1971	VOLK	SEDA	97	4	1	4	2000	034981
059	1965	CHEV	STAW	327	8	4	A	4000	079730
060	1970	CADI	DEVI	472	8	4	A	5000	045946

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VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
061	1972	CHEV	VEGA	140	4	2	4	2500	025879
063	1967	PLYM	FURY	318	8	2	A	4000	042005
064	1970	AMMO	REBE	232	6	1	A	3500	064875
065	1970	CHRY	NEWP	383	8	2	A	4500	036717
066	1970	PLYM	DUST	318	8	2	3	3000	037361
067	1971	CADI	DEVI	472	8	4	A	5000	041770
068	1968	OLDS	CUTL	350	8	2	A	3500	054881
069	1967	FORD	LTD	390	8	2	A	4000	048253
070	1972	PONT	CATA	400	8	2	A	4500	016700
071	1972	VOLK	SEDA	97	4	1	4	2250	041347
072	1972	CHEV	NOVA	250	6	1	A	3000	012834
073	1971	FORD	TORI	351	8	2	A	3500	022051
074	1965	FORD	FAIR	289	8	2	A	3500	073336
075	1971	FORD	PINT	98	4	1	4	2250	012609
076	1967	BUIC	LESA	340	8	4	A	4000	021887
077	1972	CHEV	IMPA	400	8	4	A	4500	027848
078	1972	FORD	STAW	351	8	2	A	4000	020434
079	1971	FORD	STAW	400	8	2	A	4500	035284
080	1967	CHEV	MALI	283	8	2	3	3500	075280
082	1971	PLYM	STAW	383	8	2	A	4000	050843
083	1970	DODG	DART	318	8	2	A	3000	016300
084	1970	PONT	GTO	400	8	4	A	4000	042846
085	1968	BUIC	RIVI	430	8	4	A	4500	060029
087	1967	OLDS	STAW	330	8	2	A	4000	064223
088	1967	AMMO	STAW	290	8	2	A	4000	072440
090	1970	FORD	MAVE	200	6	1	A	2750	022467
091	1973	PONT	LEMA	400	8	2	A	4000	006704
092	1970	FORD	MAVE	200	6	1	A	2750	035000
093	1972	PLYM	DUST	198	6	1	A	3000	020817
094	1969	BUIC	LESA	350	8	4	A	4500	034309
095	1968	AMMO	STAW	290	8	2	A	4000	052932
096	1965	PONT	CATA	389	8	4	A	4000	076369
097	1964	PLYM	VALI	170	6	1	3	3000	026268
098	1972	FORD	MAV[illegible]	302	8	2	A	3000	026575
099	1971	CHEV	BLA[illegible]	350	8	4	4	4000	019987
100	1969	FORD	MUST	302	8	2	A	3000	047190
101	1969	CHEV	STAW	327	8	2	A	4500	068576
102	1964	MERC	PARK	390	8	4	A	4500	055285
103	1973	FORD	MAVE	302	8	2	A	3000	009029
104	1968	PLYM	BELV	273	8	2	A	3500	058630
106	1964	FORD	GALA	289	8	2	3	4500	030087
107	1965	CHEV	CORV	164	6	2	4	2750	076078
108	1964	FORD	FALC	200	6	1	3	3000	087334
109	1966	AMMO	AMER	232	6	1	3	3000	064169
110	1969	CHEV	CHEV	307	8	2	A	3500	045577
111	1972	FORD	TORI	302	8	2	A	4000	017170
112	1970	FORD	MUST	351	8	2	A	3500	051330
113	1969	CHEV	STAW	350	8	4	A	4000	075334
115	1967	CHEV	IMPA	283	8	2	A	4000	064860
116	1973	CHEV	VEGA	140	4	2	3	2500	009706

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VEHICLES TESTED AT 5500 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
117	1970	OLDS	CUTL	350	8	2	A	4000	053727
118	1967	PONT	CATA	400	8	2	A	4000	071128
119	1971	PONT	LEMA	350	8	2	A	3500	031776
120	1967	DODG	CORO	318	8	2	A	3500	044942
121	1967	VOLK	SEDA	91	4	1	4	2000	048582
122	1967	PONT	FIRE	326	8	2	3	3500	042146
123	1964	CHEV	IMP	283	8	2	A	4000	085172
124	1973	VOLK	BUS	102	4	2	4	3000	003006
125	1971	PONT	CATA	400	8	2	A	4500	029602
126	1966	CHEV	IMPA	327	8	4	A	4000	033735
127	1966	DODG	CORO	318	8	2	A	3500	048219
128	1966	MERC	MONT	390	8	2	A	4000	108053
129	1965	CHEV	BISC	283	8	2	A	3500	073598
130	1965	FORD	MUST	200	6	1	3	2750	092515
132	1965	VOLK	SEDA	73	4	1	4	2000	089782
133	1970	FORD	TORI	351	8	2	A	3500	045898
134	1969	DODG	CORO	225	6	1	A	3500	038665
135	1969	VOLK	SEDA	91	4	1	4	2000	068227
136	1965	OLDS	CUTL	330	8	2	A	3500	045665
137	1964	CHEV	STAW	327	8	4	A	4500	071086
139	1970	FORD	TORI	250	6	1	3	3500	031895
140	1966	OLDS	DYNA	425	8	2	A	4500	048553
141	1972	TOYO	STAW	120	4	2	A	2750	009840
142	1972	CHEV	NOVA	350	8	2	A	3500	025592
143	1966	FORD	MUST	289	8	2	A	3000	038659
144	1972	FORD	GALA	400	8	2	A	4000	012721
145	1973	FORD	MAVE	302	8	2	A	3000	005516
146	1969	OLDS	DELT	455	8	2	A	4000	061594
147	1970	CHEV	IMPA	350	8	2	A	4000	080466
148	1972	PLYM	SATE	400	8	2	A	3500	014660
149	1966	FORD	GALA	352	8	4	A	4000	078274
150	1971	DODG	DART	318	8	2	A	3000	026700
151	1971	VOLV	145S	121	4	2	4	3000	045943
152	1971	FORD	GALA	351	8	2	A	4000	029562
153	1965	CHEV	BELA	283	8	2	A	4000	130460
154	1968	VOLK	SEDA	91	4	1	A	2000	050486
155	1968	CHEV	BELA	307	8	2	A	4000	066417
156	1971	VOLK	SEDA	97	4	1	4	2000	024425
157	1973	VOLK	SEDA	97	4	1	4	2000	007972
158	1970	OLDS	STAW	455	8	4	A	4500	033747
159	1968	CHEV	BELA	250	6	1	A	4000	009065
160	1969	CADI	FLEE	472	8	4	A	5000	036519
161	1969	MERC	COUG	351	8	2	A	3500	047191
162	1964	CHEV	STAW	283	8	4	A	4000	074643
163	1972	DATS	STAW	97	4	1	4	2500	024888
165	1964	PONT	CATA	389	8	2	A	4000	054195
166	1970	VOLK	SEDA	97	4	1	4	2000	012474
168	1966	VOLK	SEDA	78	4	1	4	2000	048575
169	1965	PLYM	FURY	318	8	2	A	4000	113497
170	1966	FORD	MUST	289	8	2	A	3000	081058

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VEHICLES TESTED AT 5500 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
171	1965	FORD	STAW	289	8	2	A	4500	071092
172	1964	CHEV	IMPA	283	8	2	A	3500	110629
173	1972	OLDS	CUTL	350	8	2	A	3500	026639
174	1969	FORD	FAIR	302	8	2	A	3500	055127
175	1972	CHEV	NOVA	350	8	2	A	3500	021117
176	1973	CADI	DEVI	472	8	4	A	5000	007405
177	1972	CHRY	NEWP	400	8	2	A	4500	029493
178	1964	FORD	GALA	390	8	4	A	4000	059024
179	1973	CHEV	NOVA	307	8	2	A	3500	017115
180	1968	FORD	GALA	302	8	2	A	4000	076747
181	1968	CHEV	NOVA	307	8	2	A	3000	042449
182	1968	CHEV	CAME	327	8	2	A	3500	083926
183	1971	CHEV	STAW	400	8	2	A	4500	021163
184	1971	CHEV	IMPA	350	8	2	A	4000	035988
185	1971	TOYO	CORO	71	4	2	4	2000	029881
186	1970	VOLK	SEDA	97	4	1	4	2000	048300
187	1973	FORD	LTD	351	8	2	A	4500	004725
188	1971	MERC	COUG	351	8	2	A	4000	017215
189	1971	DODG	DART	225	6	1	A	3000	011166
190	1973	PLYM	DUST	225	6	1	A	3000	008056
191	1967	CHEV	CHE2	194	6	1	3	3000	022266
192	1966	CHEV	CHEV	230	6	1	A	3500	046973
193	1969	FORD	FAIR	302	8	2	3	3500	054596
194	1968	CHEV	IMPA	327	8	4	A	4000	054000
195	1973	CHEV	CHEV	350	8	2	A	4000	006886
196	1971	CHEV	CAPR	400	8	2	A	4500	036250
197	1972	FORD	PINT	122	4	2	A	2250	011175
198	1966	CHEV	IMPA	283	8	2	A	4000	083297
199	1967	VOLK	SEDA	91	4	1	4	2000	068155
200	1972	CHEV	NOVA	307	8	2	A	3500	015710
201	1973	FORD	PINT	122	4	1	A	2500	010729
202	1973	DATS	1200	71	4	1	4	2000	000519
203	1973	CHRY	NEWP	400	8	2	A	4500	059407
204	1970	FORD	GALA	390	8	2	A	4000	020723
205	1969	CHEV	STAW	350	8	4	A	4500	093878
206	1965	CADI	FLEE	429	8	4	A	5500	053146
207	1972	VOLK	SQBK	97	4	FI	4	2500	011511
208	1971	DATS	510	97	4	1	4	2000	027615
209	1966	BUIC	ELEC	401	8	4	A	4500	056428
210	1973	VOLK	SEDA	97	4	1	4	2000	015868
211	1970	PLYM	FURY	318	8	2	A	4000	063652
212	1967	FORD	MUST	289	8	2	3	3000	051835
213	1966	CHEV	STAW	283	8	2	3	4000	061637
214	1966	PONT	CATA	389	8	2	A	4000	046086
217	1972	CADI	COUP	472	8	4	A	5000	017251
218	1973	CHEV	NOVA	307	8	2	A	3500	016372
219	1968	CHRY	STAW	383	8	4	A	4500	071302
220	1968	BUIC	LESA	350	8	4	A	4500	074568
221	1964	PONT	GRAN	389	8	4	A	4000	074401
222	1964	AMMO	AMER	196	6	1	3	3000	068526

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VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
223	1964	BUIC	WILD	401	8	4	A	4500	051818
224	1968	CHEV	MALI	250	6	1	A	3500	043307
225	1968	CHEV	STAW	396	8	4	A	4500	048577
226	1973	DODG	DART	318	8	2	A	3000	003813
227	1973	AMMO	STAW	304	8	2	A	3000	003437
228	1971	OPEL	1900	116	4	1	A	2250	011626
229	1972	VOLK	SEDA	97	4	1	4	2000	018774
230	1966	PLYM	BELF	225	6	1	3	3500	099961
231	1973	PLYM	DUST	318	8	2	A	3500	007751
232	1973	FORD	MAVE	200	6	1	3	2500	003468
233	1972	BUIC	LESA	350	8	4	A	4500	020861
234	1968	MERC	COUG	302	8	4	A	3500	074758
235	1965	BUIC	WILD	425	8	4	A	4500	078046
236	1965	CHEV	IMPA	327	8	4	A	4000	061259
237	1968	CADI	FLEE	472	8	4	A	5000	065735
238	1969	DODG	CORO	318	8	2	A	3500	051016
239	1968	VOLK	SEDA	91	4	1	4	2000	084309
240	1965	CHEV	CHEV	230	6	1	A	3000	071640
241	1965	CHEV	IMPA	396	8	4	A	3500	101402
242	1970	FORD	MUST	302	8	2	A	3500	016785
243	1969	PONT	CATA	400	8	2	A	4000	057823
245	1968	FORD	FAIR	289	8	2	3	3500	077348
246	1968	OLDS	DELT	455	8	2	A	4500	114750
247	1968	FORD	GALA	390	8	2	A	4000	046034
248	1969	PONT	LEMA	350	8	2	A	4000	027997
249	1971	PLYM	FURY	383	8	4	A	4000	030259
250	1970	CHEV	CAME	350	8	2	4	3500	047370
251	1973	CHEV	IMPA	350	8	4	A	4000	006702
252	1973	OLDS	OMEG	350	8	4	3	3500	009599
254	1970	FORD	MUST	302	8	2	A	3000	036423
255	1972	CHEV	NOVA	307	8	2	A	3000	032867
256	1966	OLDS	CUTL	330	8	2	A	3500	053077
257	1965	CHRY	STAW	413	8	4	A	5000	083241
258	1965	FORD	THUN	390	8	4	A	5000	083016
259	1966	VOLK	FAST	97	4	2	4	2250	115141
260	1971	CHRY	IMPE	440	8	4	A	5000	023677
261	1969	FORD	MUST	200	6	1	3	3000	068680
262	1973	CHEV	STAW	454	8	4	A	4500	017416
263	1968	DODG	DART	273	8	2	3	3000	065448
264	1972	OPEL	1900	116	4	2	4	2250	022672
265	1969	CHEV	CAPR	327	8	4	A	4000	030213
266	1967	FORD	MUST	200	6	1	3	3000	064477
267	1967	FORD	FALC	200	6	1	3	2750	103550
268	1973	DODG	DART	225	6	2	A	3000	025094
269	1968	TOYO	CORO	116	4	2	4	2500	061312
270	1971	CHEV	NOVA	250	6	1	A	3500	095217
271	1967	PONT	FIRE	326	8	4	A	3500	059028
272	1966	PLYM	FURY	318	8	2	A	4000	092494
273	1970	CHEV	CAPR	400	8	2	A	4000	047305
274	1970	BUIC	SKYL	350	8	4	A	4000	034266

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VEHICLES TESTED AT 5500 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	I.WT	ODOM.
276	1966	PONT	LEMA	326	8	4	A	3500	073426
277	1966	FORD	STAW	289	8	2	A	3000	084032
278	1965	FORD	MUST	289	8	4	A	3000	059885
279	1973	TOYO	STAW	120	4	2	A	2500	003829
280	1967	CHEV	STAW	327	8	4	3	4000	096491
281	1966	FORD	MUST	200	6	1	A	3000	059352
282	1968	FORD	FALC	170	6	1	3	3000	097889
283	1968	PONT	CATA	400	8	4	A	4500	075255
284	1971	AMMO	AMBA	401	8	4	A	4000	031837
285	1968	PLYM	BARR	318	8	2	A	3500	060568
286	1968	DODG	CHAR	318	8	2	A	3500	065609
287	1971	BUIC	LESA	455	8	4	A	4500	017998
288	1968	PONT	TEMP	350	8	2	A	3500	040178
289	1969	VOLK	SEDA	91	4	1	4	2000	063512
291	1969	PLYM	FURY	318	8	2	A	4000	052667
292	1971	CHEV	NOVA	307	8	2	A	3500	029533
293	1972	FORD	MUST	351	8	4	A	3500	019843
294	1969	CHRY	NEWP	383	8	2	A	4500	065163
295	1970	DODG	POLA	383	8	2	A	4500	053254
296	1965	FORD	MUST	260	8	2	A	3000	052813
297	1971	PLYM	DUST	198	6	1	3	3000	027784
298	1972	AMMO	JAVE	360	8	4	4	3500	023737
299	1972	PLYM	SATE	318	8	2	A	3500	028091
300	1973	OPEL	MANT	116	4	2	4	2250	006817
301	1973	MERC	COME	302	8	2	A	3000	010804
302	1973	BUIC	CENT	350	8	4	A	4000	006508
303	1973	PLYM	DUST	318	8	2	A	3500	006473
304	1972	DODG	CORO	318	8	2	A	3500	022983
305	1969	AMMO	AMBA	290	8	2	A	4000	054001
306	1969	BUIC	ELEC	430	8	4	A	4500	034898
307	1969	CHEV	NOVA	230	6	1	A	3000	029124
308	1969	FORD	TORI	351	8	2	A	3500	021037
309	1969	FORD	TORI	351	8	2	A	3500	074369
310	1972	FORD	MAVE	302	8	2	A	3000	008455
311	1972	FORD	MAVE	250	6	1	A	2750	022036
312	1972	MERC	COME	302	8	2	A	3000	008589
314	1971	FORD	BRON	302	8	2	3	3500	020440
315	1971	OLDS	CUTL	350	8	4	A	3500	026169
316	1970	MERC	MONT	302	8	2	3	3500	027532
317	1971	FORD	MAVE	200	6	1	A	2750	023567
318	1971	FORD	GALA	400	8	2	A	4000	040209
319	1971	FORD	TORI	351	8	2	A	3500	013444
320	1973	FORD	MUST	351	8	2	A	3500	003445
321	1970	CHEV	NOVA	250	6	1	A	3500	012130
322	1970	CHEV	NOVA	307	8	2	A	3500	032511
323	1970	PONT	TEMP	350	8	2	A	3500	030849
324	1973	CHEV	NOVA	250	6	1	3	3500	004682
325	1973	FORD	GALA	351	8	2	A	4500	016385
326	1969	TOYO	CORO	116	4	2	4	2500	076050
327	1970	TOYO	CORO	113	4	2	4	2500	051836

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VEHICLES TESTED AT 10000 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	WEIGHT	ODOM.
504	1972	CHEV	NOVA	307	8	2	A	3202	025934
505	1968	CHRY	NEWY	383	8	4	A	4090	074675
506	1969	CHEV	SEDA	327	8	2	A	3760	077521
507	1971	PLYM	SUBU	383	8	2	A	3930	033416
508	1971	OLDS	SEDA	350	8	4	M	3398	015699
509	1970	FORD	STAW	351	8	4	A	3615	039366
513	1965	DODG	POLA	383	8	2	A	3875	113674
514	1970	FORD	SEDA	302	8	2	A	3695	048204
515	1969	FORD	STAW	302	8	2	A	3526	064274
516	1969	BUIC	LESA	350	8	4	A	3966	067219
517	1973	CHEV	CUST	350	8	4	A	3296	009595
519	1965	FORD	CUST	289	8	2	A	3358	080180
520	1965	VOLK	SEDA	73	4	1	M	1600	072753
522	1971	BUIC	LESA	350	8	4	A	4147	030125
523	1969	PLYM	FURY	318	8	2	A	3650	019076
524	1968	CHEV	IMPA	307	8	2	A	3623	084866
525	1966	FORD	FAIR	289	8	2	A	3351	091315
526	1971	CHRY	NEWP	383	8	2	A	4191	027776
527	1972	TOYO	CORO	97	4	2	M	2000	013896
528	1966	FORD	MUST	289	8	4	M	2733	050000
529	1969	FORD	TORI	351	8	2	A	3211	052597
530	1969	FORD	MUST	250	6	1	M	2713	042561
531	1969	DODG	CORO	318	8	2	A	3181	044381
532	1972	PONT	LEMA	350	8	2	A	3800	019718
535	1967	MERC	COLO	410	8	4	A	4294	081564
537	1968	BUIC	LESA	350	8	4	A	3980	021520
538	1966	VOLK	SEDA	78	4	1	M	1653	007818
540	1972	PLYM	SATE	318	8	2	A	3280	024668
542	1973	TOYO	CORO	120	4	2	M	2480	000419
544	1965	PONT	CATA	389	8	2	A	4210	017248
545	1971	CHEV	VEGA	140	4	1	M	2230	028110
546	1970	OLDS	CUTL	350	8	4	A	3489	023988
547	1970	AMMO	REBA	304	8	2	A	3290	013974
549	1973	VOLK	SEDA	97	4	1	M	1911	001531
552	1968	FORD	GALA	390	8	2	A	3607	071051
553	1965	CHEV	MALI	327	8	4	A	3355	081082
554	1967	CHEV	STAW	283	8	2	A	3890	044915
555	1968	PONT	EXEC	400	8	4	A	4022	064400
556	1973	OLDS	SEDA	350	8	2	A	3380	009432
557	1972	CHEV	MALI	350	8	2	A	3580	014579

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VEHICLES TESTED AT 10000 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	WEIGHT	ODOM.
558	1969	VOLK	SEDA	91	4	2	M	1742	056492
560	1973	PONT	LEMA	350	8	2	A	3821	001171
561	1971	CHEV	CHEV	307	8	2	A	3342	019902
564	1966	OLDS	DYNA	330	8	4	M	3957	072423
565	1969	PONT	TEMP	350	8	2	M	3504	066192
566	1972	CHEV	VEGA	140	4	2	M	2294	048226
567	1973	BUIC	CENT	350	8	4	A	3797	005400
568	1971	FORD	RANC	351	8	2	A	3265	042484
570	1969	VOLK	SEDA	97	4	1	M	1742	076216
573	1970	FORD	MAVE	250	6	1	A	2421	053802
574	1966	BUIC	LESA	340	8	4	A	3828	047064
575	1964	FORD	THUN	390	8	4	A	4431	075441
576	1965	MERC	MONT	390	8	4	A	3928	066364
577	1971	DODG	DART	318	8	2	A	2900	018372
578	1970	CHEV	CAMA	350	8	2	M	3172	035857
580	1973	CHEV	IMPA	350	8	2	A	4138	010218
582	1968	OLDS	CUTL	350	8	2	A	3108	034953
584	1973	FORD	TORI	351	8	2	A	3664	005324
585	1971	CHEV	CAPR	400	8	2	A	3964	015646
589	1966	CHEV	CAPR	327	8	4	A	3585	056297
592	1964	PONT	GRAN	389	8	4	A	3930	044535
596	1966	MERC	COME	390	8	4	M	3315	016555
597	1968	CHEV	CAPR	327	8	4	A	4062	069657
598	1970	MERC	MONT	351	8	4	A	3298	038389
599	1970	CADI	SEDA	472	8	4	A	4762	049803
600	1972	DODG	SEDA	318	8	2	M	2825	026032
601	1969	AMMO	JAVI	290	8	2	A	3013	094002
602	1970	VOLK	SEDA	97	4	1	M	1807	037850
603	1970	VOLK	SEDA	97	4	1	M	1807	033173
606	1968	MERC	MONT	390	8	4	M	3081	075683
607	1965	CHEV	BELA	283	8	4	M	3530	094705
608	1964	CHEV	BISC	283	8	2	M	3365	006891
609	1967	BUIC	LESA	340	8	4	A	3878	077681
611	1973	MERC	MONT	351	8	4	A	3662	009243
614	1971	FORD	CUS	429	8	4	A	3723	098266
616	1969	CHEV	NOVA	307	8	2	A	2895	056394
617	1964	DODG	330	318	8	4	M	3325	019580
618	1971	PONT	CATA	350	8	2	A	4107	069069
619	1969	CHEV	IMPA	350	8	4	A	3760	077679
620	1971	FORD	PINT	122	4	2	A	1993	028308

VEHICLES TESTED AT 10000 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	WEIGHT	ODOM.
622	1965	FORD	MUST	200	6	1	A	2629	057950
624	1971	CHEV	CAPR	350	8	2	A	3964	024631
627	1973	PLYM	STAW	360	8	2	A	4465	015366
628	1965	FORD	TUDO	170	6	2	M	2595	090633
630	1973	FORD	BRON	302	8	2	M	4000	004757
631	1967	AMMO	STAW	232	6	1	A	2769	060107
633	1964	CHEV	TRUC	292	6	1	M	3310	040425
635	1965	OLDS	85	330	8	2	A	3174	080757
636	1971	FORD	MAVE	170	6	1	M	2508	029356
637	1966	FORD	MUST	20	6	1	M	2488	060304
638	1971	MERC	COUG	351	8	2	M	3360	040442
641	1968	CHEV	CORV	327	8	2	M	2500	045067
642	1964	AMMO	RAMB	196	6	1	M	2898	100900
643	1967	CHEV	CHEV	230	6	1	M	3260	090795
644	1966	CHEV	IMPA	283	8	2	M	3565	084912
648	1967	CHRY	STAW	383	8	2	A	4495	090790
649	1973	VOLK	SEDA	97	4	1	M	1911	018550
650	1968	PONT	TEMP	350	8	2	A	3488	046019
651	1970	BUIC	SKYL	350	8	4	A	3375	048863
652	1966	CHRY	SEDA	383	8	4	A	4000	007055
653	1965	CHEV	CAPR	327	8	4	A	3460	098601
655	1970	CHEV	VAN	307	8	2	M	3467	044337
656	1964	VOLK	KARM	73	4	1	M	1742	022375
657	1972	CHRY	NEWP	360	8	2	A	3715	035162
658	1971	TOYO	LAND	237	6	2	M	3435	038006
659	1967	FORD	FAIR	289	8	2	A	2928	032526
660	1965	BUIC	ELEC	401	8	4	A	4208	054640
662	1967	CHEV	IMPA	327	8	4	A	3500	018894
663	1968	PLYM	BARR	273	8	2	A	2895	067865
664	1966	DODG	CORN	273	8	2	A	3077	098720
665	1966	CHEV	BELA	283	8	4	M	3525	088539
666	1968	FORD	FAIR	289	8	2	A	3017	052360
668	1968	FORD	GALA	302	8	2	A	3895	003895
669	1970	PONT	LEMA	350	8	2	A	3002	033590
670	1972	BUIC	LESA	350	8	4	A	4166	010824
671	1970	DODG	CORN	318	8	2	M	3625	035887
674	1972	AMMO	GREM	258	6	1	A	2494	013505
675	1973	AMMO	GREM	258	6	2	A	2494	011121
676	1968	DODG	DART	318	8	2	A	2726	086682
678	1971	VOLK	SEDA	97	4	1	M	1742	053466

VEHICLES TESTED AT 10000 FEET

VEH	YEAR	MAKE	MODEL	CID	CYL	CARB	TRAN	WEIGHT	ODOM.
681	1971	VOLK	STAW	97	4	FI	M	2051	053324
683	1968	VOLK	SEDA	91	4	1	M	1808	080295
684	1964	CHEV	IMPA	283	8	2	M	3525	088296
685	1972	CHEV	IMPA	400	8	4	A	4113	013566
686	1967	PONT	TEMP	326	8	4	M	3130	060038
687	1970	FORD	GALA	351	8	2	A	3770	012190
691	1967	FORD	MUST	200	6	1	M	2624	054321
693	1966	PONT	TEMP	326	8	2	A	3571	071577
695	1964	BUIC	WILD	401	8	4	A	4021	005393
696	1966	AMMO	AMBA	327	8	4	M	4241	049804
698	1967	VOLK	SEDA	91	4	1	M	1698	066890
702	1973	DODG	DART	318	8	2	A	2890	002511
703	1965	FORD	GALA	390	8	4	A	3386	099321
704	1967	PLYM	FURY	383	8	2	A	3595	068268
705	1973	FORD	TRUC	360	8	2	A	3590	012601
707	1973	FORD	PINT	122	4	2	A	2145	006714
709	1968	CHEV	CAMA	250	6	1	M	2855	086854
710	1966	CHEV	MALI	283	8	2	A	2640	094546
711	1973	CHEV	NOVA	250	6	1	M	3033	013959
713	1973	CHRY	STAW	440	8	4	A	4670	010144
715	1965	CHRY	NEWP	383	8	2	A	4045	093620
716	1966	PLYM	BARR	273	8	4	M	2930	084554
717	1973	CHEV	LAGU	454	8	4	A	4189	013473
719	1967	FORD	GALA	240	6	1	A	3459	023077
720	1964	CHEV	IMPA	327	8	4	A	3415	073136
721	1964	FORD	MUST	289	8	2	A	2720	030541
722	1971	AMMO	MATA	360	8	4	A	3324	013959
723	1967	OLDS	442	425	8	4	M	3914	080000
725	1965	PLYM	FURY	318	8	2	A	3715	078365
726	1970	CHEV	MONT	454	8	4	A	3713	048537
727	1966	FORD	GALA	390	8	2	A	3500	062587
728	1972	MERC	SEDA	429	8	4	A	4477	005400
729	1969	MERC	MONT	390	8	2	A	4277	049707

AUTOMOTIVE TESTING LABORATORIES, INC.
19900 E. COLFAX, AURORA, COLO. 80011

Appendix 2

PREDICTION OF MASS EMISSIONS FROM KEYMODE EMISSION CONCENTRATIONS

This analysis was performed in order to reliably predict mass emissions from emission concentrations obtained through key-mode and idle testing procedures. During the course of testing at 5500 feet, there were 300 tests conducted on a representative sample of cars. The 300 tests were performed on vehicles as-received and should represent the normal state of repair.

The tests consisted of a mass emission test utilizing 1975 EPA procedures, an emission concentration test utilizing the key-mode test procedure, and an emission concentration test with the vehicle in neutral gear and the engine at 2500 RPM.

Tests conducted at 10,000 feet were performed on a representative sample of 153 vehicles. Because of the infeasibility of transporting CVS equipment, the tests at 10,000 feet consisted of a key-mode test and a 2500 RPM test, resulting in a set of emission concentrations which were then converted to mass emissions. Conversion of concentrations to mass emissions required the generation of an accurate relationship between the concentrations and mass emissions. This relationship was found by performing a multiple regression analysis on the data collected at 5500 feet and assumed that the relationship found would be valid for tests conducted at 10,000 feet. It should be noted that a certain number of HC readings and a certain number of CO readings were off scale. Before the regression analysis could be performed it was necessary to assign some value to these readings. At 5500 feet, during the key-mode and 2500 RPM tests, simultaneous readings were taken with the laboratory equipment described in Volume II. These readings were consulted and average off-scale readings for HC and CO were obtained. An off-scale HC Reading was found to be 2000 ppm and an off-scale CO reading was 10.58%. These values were also used for off-scale readings at 10,000 feet.

Preliminary multiple regression analysis revealed that the number of cylinders and whether the vehicle was controlled or pre-controlled were of primary importance in predicting the mass emissions. Consequently, the vehicle population was divided into six sub-populations before the final regression analysis was run.

The sub-populations are:

1964-1967	4 cylinder vehicles
1968-1973	4 cylinder vehicles
1964-1967	6 cylinder vehicles
1968-1973	6 cylinder vehicles
1964-1967	8 cylinder vehicles
1968-1973	8 cylinder vehicles

A multiple linear regression analysis was then run for each sub-population/ pollutant combination. Each of these computer runs resulted in an equation of the following form.

$$M = A_0 + A_1 \times C_{idle} + A_2 \times C_{LC} + A_3 \times C_{HC} + A_4 \times C_{2500}$$

Where:

M = Mass emission of the given pollutant

C_{idle} = Concentration at key-mode idle

C_{LC} = Concentration at key-mode low cruise

C_{HC} = Concentration at key-mode high cruise

C_{2500} = Concentration at 2500 RPM

A_0, A_1, A_2, A_3, A_4 = Coefficients resulting from regression analysis

The coefficients obtained are shown on the following page. There are no A_4 coefficients for NOx because these reading are not available at 5500 feet. To verify the validity of these equations, the concentration data at 5500 feet were used to predict mass emissio s. These predicted values were compared to the actual measured values resulting in the following correlation coefficients.

HC	Correlation Coefficient	= 0.826
CO	" "	= 0.878
NOx	" "	= 0.850

With 300 vehicles in the sample the correlation coefficients indicate that the predicted values closely match the measured values of mass emission.

As a final check predicted mass emissions at 5500 feet were used in the data analysis computer program. The resulting table shown on page 34 can be compared to the table entitled EXHAUST EMISSIONS AT 5500 FEET in appendix 3.

Population		A_0	A_1	A_2	A_3	A_4
HC						
Pre-Control	4 cyl.	-2.45736	0.00208	-0.04760	0.09314	0.00331
Controlled	4 cyl.	2.61735	0.00104	0.00590	0.00085	0.00258
Pre-Control	6 cyl.	5.41176	0.00310	-0.01766	0.01220	0.00620
Controlled	6 cyl.	3.95373	0.00503	0.00391	-0.00648	-0.00006
Pre-Control	8 cyl.	4.87529	0.00182	0.00301	0.00607	0.00191
Controlled	8 cyl.	2.46477	0.00133	0.00139	0.00724	0.00439
CO						
Pre-Control	4 cyl.	110.260	11.856	-35.626	-6.974	14.099
Controlled	4 cyl.	34.203	0.801	8.406	3.442	1.172
Pre-Control	6 cyl.	31.482	4.300	9.044	3.441	0.056
Controlled	6 cyl.	40.072	-1.664	16.730	1.869	2.684
Pre-Control	8 cyl.	40.441	5.316	8.276	2.205	7.863
Controlled	8 cyl.	41.353	2.420	10.852	6.507	5.787
NOx						
Pre-Control	4 cyl.	1.11518	-0.02406	0.00044	0.00055	
Controlled	4 cyl.	0.67221	0.00389	0.00094	0.00022	
Pre-Control	6 cyl.	0.45620	0.00700	0.00064	0.00029	
Controlled	6 cyl.	0.33778	-0.00011	0.00143	0.00028	
Pre-Control	8 cyl.	0.15562	0.00179	0.00131	0.00053	
Controlled	8 cyl.	0.48299	0.00203	0.00107	0.00047	

EXHAUST EMISSIONS AT 5500 FEET

PREDICTED USING KEYMODE MODEL

	# OF VEH.	HC MEAN	HC S.D.	CO MEAN	CO S.D.	NOX MEAN	NOX S.D.
*VEHICLE MAKE							
AMER. MOTORS	10	8.12	2.58	100.5	37.7	2.65	1.17
BUICK	15	10.49	7.23	143.6	53.4	2.09	1.07
CADILLAC	10	6.56	2.28	110.5	48.3	2.16	0.95
CHEVROLET	67	8.47	5.15	118.7	53.6	2.36	1.15
CHRYSLER	10	8.02	3.30	149.4	63.3	2.06	0.89
DATSUN	3	4.72	0.76	54.5	0.9	2.68	0.39
DODGE	18	7.72	2.76	110.6	40.8	3.20	1.50
FORD	68	7.75	4.03	100.7	32.1	3.01	1.23
LINCOLN	0						
MERCURY	11	8.88	3.89	106.7	60.4	3.25	1.81
OLDSMOBILE	16	8.26	6.07	128.3	42.6	2.06	0.79
OPEL	3	5.02	1.73	62.0	4.6	3.06	0.82
PLYMOUTH	22	8.47	5.21	118.2	38.1	2.49	1.12
PONTIAC	20	8.49	5.87	112.9	51.7	2.78	1.16
TOYOTA	6	5.03	1.50	68.1	37.7	2.07	0.85
VOLKSWAGON	20	6.30	2.14	82.5	26.7	2.22	0.60
VOLVO	1	4.87	0.00	49.9	0.0	4.36	0.00
*MODEL YEAR							
1964	22	10.21	2.09	151.9	55.5	1.93	1.23
1965	30	11.45	6.15	143.3	44.9	1.93	1.10
1966	29	10.84	5.62	137.0	41.5	2.38	1.08
1967	29	10.43	2.54	142.3	41.1	2.19	1.13
1968	30	7.00	2.55	116.1	53.9	2.86	1.55
1969	29	7.12	4.95	98.3	27.4	2.99	1.01
1970	30	7.28	4.57	86.4	31.4	3.27	0.98
1971	35	6.71	4.85	84.5	28.6	3.05	1.17
1972	33	5.55	2.00	90.6	37.9	2.63	0.90
1973	33	4.73	1.32	75.2	20.2	2.41	1.03
*DISPLACEMENT							
LESS THAN 151	39	5.82	1.83	79.2	29.6	2.25	0.79
151 - 250	47	6.73	2.69	97.3	40.1	2.40	1.14
251 - 350	126	9.21	5.16	124.4	46.1	2.63	1.24
MORE THAN 350	88	7.85	4.83	110.8	49.8	2.79	1.27
*INERTIA WEIGHT							
1800 - 2799	46	5.86	1.83	80.1	28.9	2.30	0.86
2800 - 3799	127	7.85	3.95	107.7	41.7	2.67	1.22
3800 - 4799	112	9.16	5.78	125.6	53.0	2.64	1.28
4800 - 5799	15	6.76	2.08	111.4	39.8	2.41	1.11
*POPULATIONS							
1964 - 1967	110	10.77	4.57	143.1	45.1	2.12	1.13
1968 - 1973	190	6.36	3.73	91.3	36.5	2.86	1.15
ALL VEHICLES	300	7.98	4.58	110.3	47.0	2.59	1.19

AUTOMOTIVE TESTING LABORATORIES, INC.
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EXHAUST EMISSIONS AT 600 FEET

1975 FEDERAL TEST PROCEDURE

	# OF VEH.	HC MEAN	HC S.D.	CO MEAN	CO S.D.	NOX MEAN	NOX S.D.
*VEHICLE MAKE							
AMER. MOTORS	5	5.40	2.50	102.7	65.2	2.84	1.40
BUICK	12	4.35	1.73	67.8	34.0	4.51	1.51
CADILLAC	4	3.22	2.42	57.9	59.7	5.05	3.26
CHEVROLET	39	5.35	2.92	65.2	35.5	3.61	1.43
CHRYSLER	4	4.58	0.68	67.6	38.2	4.30	1.27
DATSUN	2	2.60	0.64	17.4	9.7	4.90	0.89
DODGE	10	4.60	2.28	58.3	25.1	4.84	1.59
FORD	35	5.82	6.58	50.5	29.3	4.79	1.70
LINCOLN	1	3.24	0.00	58.9	0.0	4.55	0.00
MERCURY	7	8.23	10.20	43.9	19.9	6.54	2.30
OLDSMOBILE	11	4.63	2.78	58.1	27.4	4.58	1.21
OPEL	1	1.69	0.00	41.8	0.0	1.56	0.00
PLYMOUTH	12	3.53	1.20	55.7	32.9	5.11	1.67
PONTIAC	14	6.41	6.86	61.1	20.7	4.79	1.39
TOYOTA	3	4.51	4.82	70.7	89.0	2.15	1.56
VOLKSWAGON	10	4.29	2.30	49.4	22.4	2.16	0.70
VOLVO	0						
*MODEL YEAR							
1964	0						
1965	0						
1966	17	10.99	9.37	89.5	45.1	3.49	1.88
1967	18	6.84	2.99	80.3	31.9	3.82	2.15
1968	21	6.63	6.09	61.3	29.0	4.43	2.00
1969	22	4.80	2.31	61.9	36.2	5.31	1.89
1970	27	3.73	1.13	49.4	23.5	4.55	1.67
1971	30	4.06	1.97	55.8	31.2	3.80	1.43
1972	35	2.81	0.96	40.4	24.9	4.47	1.43
1973	0						
*DISPLACEMENT							
LESS THAN 151	20	4.02	2.48	50.2	36.6	2.45	1.16
151 - 250	18	5.08	5.15	55.3	43.2	3.89	1.85
251 - 350	73	5.02	2.61	63.4	33.5	4.24	1.53
MORE THAN 350	59	5.72	6.49	57.8	31.0	5.12	1.74
*INERTIA WEIGHT							
1800 - 2799	22	4.11	2.48	51.6	36.0	2.43	1.11
2800 - 3799	46	4.58	3.40	53.4	32.6	4.08	1.55
3800 - 4799	92	5.96	5.47	66.7	33.8	4.69	1.70
4800 - 5799	10	2.62	1.09	31.0	15.6	5.78	1.75
*POPULATIONS							
1964 - 1967	35	8.85	7.08	84.7	38.6	3.66	2.00
1968 - 1973	135	4.19	3.04	52.4	29.6	4.47	1.70
ALL VEHICLES	170	5.15	4.58	59.0	34.2	4.30	1.79

AUTOMOTIVE TESTING LABORATORIES, INC.
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EXHAUST EMISSIONS AT 5500 FEET

1975 FEDERAL TEST PROCEDURE

	# OF VEH.	HC MEAN	HC S.D.	CO MEAN	CO S.D.	NOX MEAN	NOX S.D.
*VEHICLE MAKE							
AMER. MOTORS	10	7.33	2.38	102.9	27.9	2.70	1.27
BUICK	15	10.01	6.82	148.3	43.4	2.34	1.22
CADILLAC	10	6.89	3.81	127.9	60.4	2.69	1.28
CHEVROLET	67	8.97	7.04	119.4	63.8	2.29	1.24
CHRYSLER	10	11.51	9.14	172.7	67.8	2.11	1.07
DATSUN	3	4.21	0.95	41.1	5.0	2.77	1.00
DODGE	18	7.28	5.09	102.2	42.8	2.96	1.14
FORD	68	7.23	3.93	95.2	35.8	2.98	1.71
LINCOLN	0						
MERCURY	11	7.84	4.10	99.4	69.6	3.49	2.67
OLDSMOBILE	16	7.80	4.38	119.7	40.3	2.36	1.08
OPEL	3	4.51	1.54	70.0	29.3	2.19	1.08
PLYMOUTH	22	8.38	5.58	123.0	46.2	2.26	1.06
PONTIAC	20	9.17	7.29	118.3	64.8	2.67	1.32
TOYOTA	6	4.43	1.62	72.8	40.2	2.52	0.96
VOLKSWAGON	20	6.36	2.67	81.9	23.4	2.21	0.88
VOLVO	1	3.29	0.00	30.9	0.0	4.82	0.00
*MODEL YEAR							
1964	22	10.03	3.29	146.7	58.5	2.13	1.48
1965	30	11.92	7.34	148.4	64.1	2.03	1.16
1966	29	11.11	7.30	140.6	39.8	2.16	0.91
1967	29	9.80	3.07	137.4	47.5	2.16	1.67
1968	30	7.21	2.73	113.5	53.2	2.83	1.78
1969	29	7.14	6.34	97.5	37.9	3.24	1.30
1970	30	6.98	5.09	86.3	40.3	3.37	1.39
1971	35	6.45	4.76	82.6	38.6	3.20	1.39
1972	33	6.04	5.71	92.6	52.6	2.64	1.08
1973	33	4.57	2.01	78.3	33.2	1.99	0.86
*DISPLACEMENT							
LESS THAN 151	39	5.82	2.43	79.2	33.2	2.25	1.00
151 - 250	47	6.72	3.50	97.3	43.6	2.40	1.39
251 - 350	126	8.97	6.20	117.9	52.2	2.47	1.29
MORE THAN 350	88	8.19	6.07	120.2	61.1	3.02	1.63
*INERTIA WEIGHT							
1800 - 2799	46	5.79	2.35	77.9	31.7	2.36	1.26
2800 - 3799	127	7.57	4.19	103.6	47.1	2.44	1.25
3800 - 4799	112	9.48	7.38	129.0	59.7	2.85	1.62
4800 - 5799	15	6.89	3.25	126.6	51.3	2.70	1.18
*POPULATIONS							
1964 - 1967	110	10.77	5.77	143.1	52.5	2.12	1.31
1968 - 1973	190	6.36	4.71	91.3	44.1	2.87	1.39
ALL VEHICLES	300	7.98	5.54	110.3	53.5	2.59	1.41

AUTOMOTIVE TESTING LABORATORIES, INC.
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EXHAUST EMISSIONS AT 10000 FEET

PREDICTED USING KEYMODE MODEL

	# OF VEH.	HC MEAN	HC S.D.	CO MEAN	CO S.D.	NOX MEAN	NOX S.D.
*VEHICLE MAKE							
AMER. MOTORS	8	8.87	4.82	115.7	53.6	2.36	1.61
BUICK	10	9.46	2.70	167.1	37.1	1.97	2.64
CADILLAC	1	5.97	0.00	108.0	0.0	2.31	0.00
CHEVROLET	36	10.83	5.98	136.4	36.6	1.19	0.67
CHRYSLER	7	17.63	11.84	130.7	27.5	1.07	0.51
DATSUN	0						
DODGE	9	8.68	3.31	117.6	36.3	1.69	0.59
FORD	31	8.98	4.47	114.5	39.1	2.20	1.49
LINCOLN	0						
MERCURY	9	13.20	7.58	130.8	68.9	2.21	1.51
OLDSMOBILE	7	9.08	2.15	131.5	53.1	1.30	0.99
OPEL	0						
PLYMOUTH	8	10.20	4.31	148.9	51.2	1.19	0.76
PONTIAC	11	12.07	6.51	149.3	26.8	1.21	0.62
TOYOTA	3	5.50	1.17	80.1	15.7	2.00	0.40
VOLKSWAGON	13	14.66	12.73	73.8	40.3	1.85	0.65
VOLVO	0						
*MODEL YEAR							
1964	11	15.12	10.19	118.9	46.9	1.70	1.46
1965	15	14.22	7.15	130.4	45.0	1.22	0.65
1966	17	17.23	9.29	145.1	61.4	1.16	1.49
1967	14	10.69	3.42	127.1	40.1	1.11	0.76
1968	16	8.21	3.02	119.1	52.2	2.13	1.16
1969	14	9.39	2.29	128.7	38.7	2.68	2.22
1970	16	9.80	5.85	124.8	40.6	1.67	0.95
1971	19	9.00	6.08	117.3	40.3	1.91	1.20
1972	12	8.68	6.72	126.1	47.8	1.62	0.58
1973	19	6.75	2.08	121.6	46.7	1.59	0.73
*DISPLACEMENT							
LESS THAN 151	19	11.90	11.21	76.2	35.7	1.87	0.64
151 - 250	14	7.20	3.47	100.5	26.5	2.10	1.77
251 - 350	77	10.90	5.50	141.1	41.4	1.54	1.30
MORE THAN 350	50	12.67	8.81	121.5	49.3	1.66	1.09
*INERTIA WEIGHT							
1800 - 2799	27	7.07	2.64	96.5	35.8	2.00	1.21
2800 - 3799	78	10.91	5.99	133.1	41.3	1.61	1.15
3800 - 4799	41	10.94	6.30	140.4	45.5	1.63	1.52
4800 - 5799	0						
*POPULATIONS							
1964 - 1967	57	14.42	8.04	131.8	49.4	1.27	1.14
1968 - 1973	96	8.57	4.66	122.5	43.5	1.92	1.26
ALL VEHICLES	153	10.75	6.74	125.9	45.9	1.68	1.25

AUTOMOTIVE TESTING LABORATORIES, INC.
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VEH.NO._____ Emissions Tested at_____ Date_____

Year_____ Make_____ Model_____ Odometer_____

#cyl_____ CID_____ BBL_____ Trans_____ GVW_____ HP_____

EMC_____ EVC_____ PCV_____ NO_x Control_____

KEY MODE

Bar._____ Dry bulb_____ Wet bulb_____

	HC	CO	NO_x	RPM	MISFIRE?
Idle					
Low Cruise					
High Cruise					
2500 RPM					

Engine Data

Dwell_____° Timing_____° Air Cleaner_____

PCV_____ Choke_____ Heat riser_____ Vac.Kick_____

Original type carb?_____ Ever replaced?_____

Disabled or missing emission control hardware?_____

Describe_____

Vehicle has been altitude calibrated at last tune?_____:

Carb only_____ Timing only _____ Both_____

Installed manual choke?_____

Scope Pattern Data

Points/condenser_____ Ignition wires_____

Plugs_____

Has vehicle ever been: Run on a dyno_____

in an emission test program_____

engine replaced_____

Automotive Testing Laboratories, Inc.

General Information

This information will be punched and matched with vehicles tested at 5,400 ft. and sea-level.

The results will be useful in reflecting the effect of local conditions on emission levels.

The order in which the form is completed does not matter, but it would help to record the "Key Mode" cycle last if the vehicle owner is watching and is interested in the emission readings. (Owners questions are more easily answered with complete data.)

The information sheet is roughly divided into sections.

First four lines-----

Deals with vehicle and engine identification: use standard reference sources and visual inspection to obtain accurate data here.

"Key Mode"

Records the emission levels in the vehicle exhaust during these driving modes.

"Engine Data"

Indicates engine conditions which May or May not have an effect on emission levels.

"Scope Patterns"

Identifies malfunctions which have a direct effect on emission levels.

Last Three Lines

Is useful as background information.

Answer Guide

Air cleaner - dirty, plugged, clean

BBL - 1, 2, 3, 4 barrel, or 3x2, or two 4 barrel, or fuel injection.

Barometer - present reading.

Both - yes, no, or "?"

Cyl - 4, 6, 8 cylinder engine.

CID - cubic inch displacement as advertised or cubic centimeters advertised.

Choke - Free and working, stretch open or part closed on fully warm engine, or missing.

Carb only - Yes, no or "?"

Date - Today

Dry bulb - Dry thermometer reading at time of "Key Mode" test.

Dwell - Actual dwell reading of engine at idle speed.

Disabled, etc. - Yes or no

Describe - List anything you recognize, air cleaners, air pumps, VAC hoses, temp. sensors, etc.

Emissions tested at - Campus altitude is _____

EMC - If vehicle has some emission controls factory installed say "yes"

EVC - If vehicle has evaporation control system say "yes"

Ever replaced - Yes, no, or "?"

GVW - Gross vehicle weight from tables or accurate guess.

Heat riser - OK, stuck open, stuck closed
HP - Dyno load set for "Key Mode" test.
Make - Ford, Chevy, etc.
Misfire - No (Yes if you feel it or hear it)
Model - Sedan, coupe, pick up etc.

Installed manual choke - If you see a bond choke replacing an O.E.M. auto choke say yes otherwise no.

Ignition wires - Ok, some open, some grounded.

NOx Control - Yes or no (should only see it on 1973 - 74 models)

Odometer - Actual observed: If over 100,000 add "0" example 3659 should be entered 03659

Original type - Yes or no

PCV - Positive crankcase ventilation valve. Answer yes or no

PCV Engine data - OK, or plugged.

Points/cond - OK, or poor condition pattern.

Plugs - OK, shorted, open, etc.

Trans. - Automatic or manual.

Timing - Actual observed setting at idle speed with Vac line disconnected & plugged.

Timing only - Yes, no, or ?

Veh. No. next unused number from list.

Vac kick - OK or faulty

Vehicle has.... - Yes, no or ?

Wet bulb - Thermometer reading (the wet one) at time of "Key Mode" test.